Higgs decay to W^+W^- and llll on NCStandard Model

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Outlines

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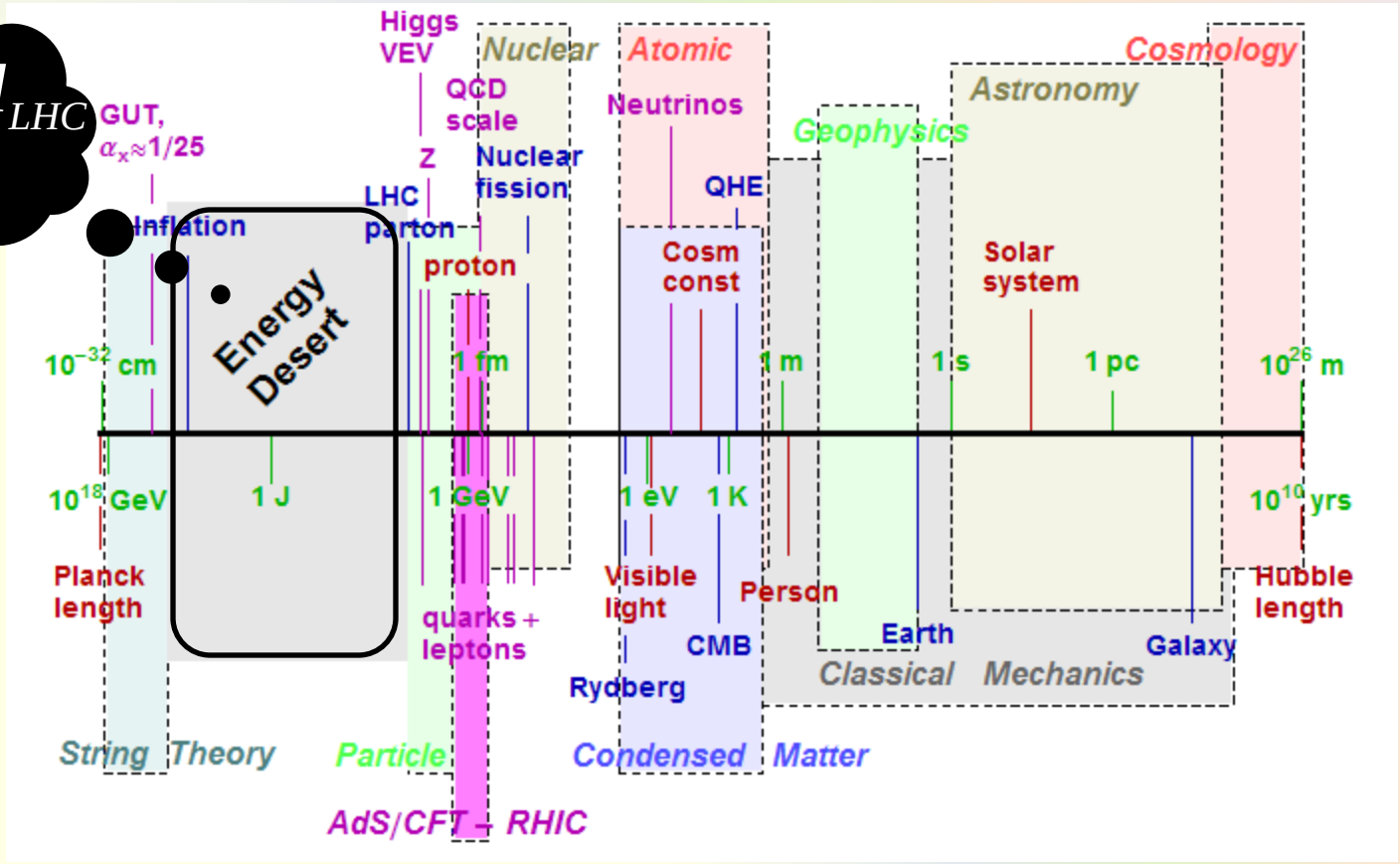
- NC SpaceTime
- Standard Model
- Higgs decay channels in SM
- NCSM
- H decay to W^+W^- and four lepton in NCSpacetime
- Conclution

Motivation

Much of theoretical physics is based on length scales,

$l_p < l < l_{LHC}$?



NC SpaceTime

- Spacetime quantization requires to prom… time coordinates to hermitean operators… not commute:

$$[\hat{x}^i, \hat{x}^j] = i\theta^{ij} \propto$$

- θ^{ij} is real and antis… matrix.

- If θ^{ij} … bove commentator shows H… algebra

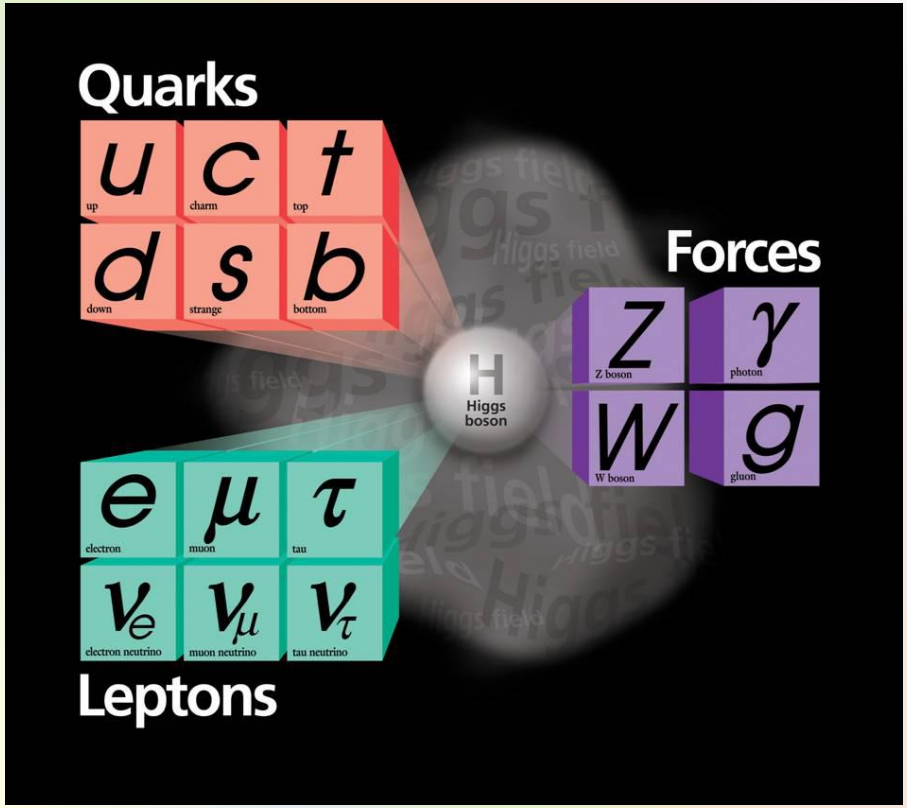
$$\Delta x^i \Delta x^j \geq \frac{1}{2}\left|\theta^{ij}\right|$$

$$\theta^{ij} \sim \hbar \qquad [\hat{x}^i, \hat{p}^j] = i\hbar\delta^{ij}$$

Standard model

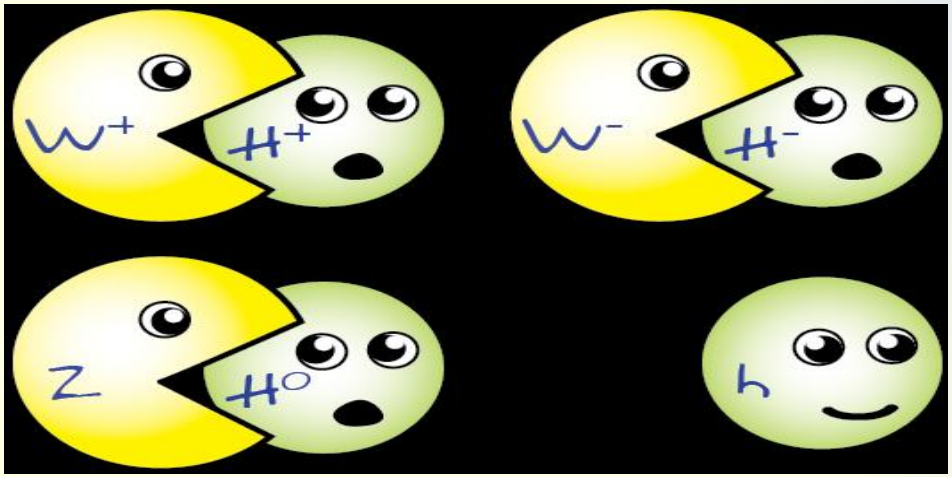
The standard model consists of three elements:

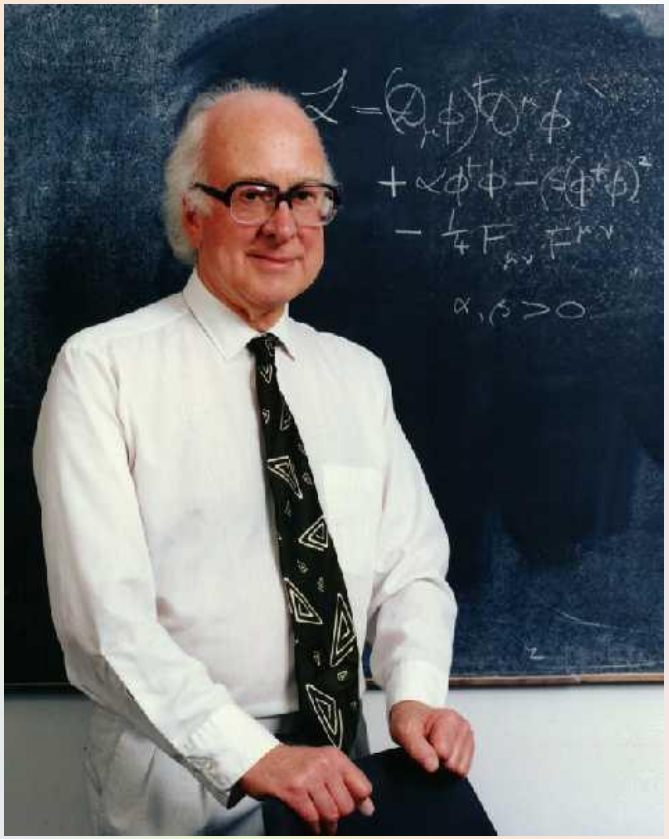
- Leptons and quarks are the basic constituents of matter;
- The interactions are mediated by gauge fields;
- The masses are generated by the Higgs mechanism.



What does Higgs theory imply?

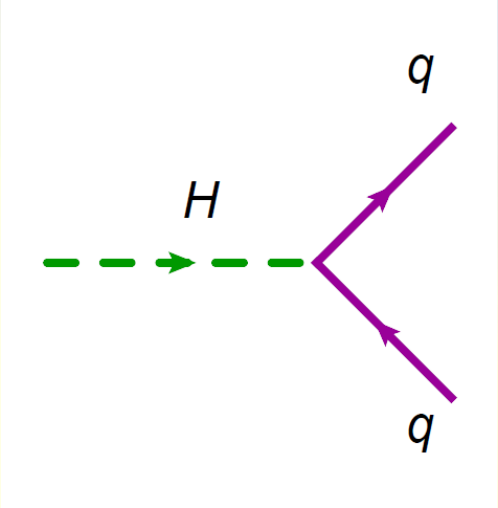
Higgs mechanism gives mass to W and Z bosons, and to the matter particles.

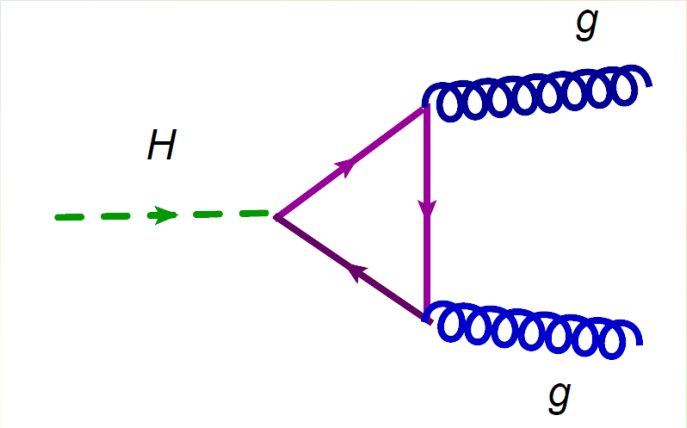


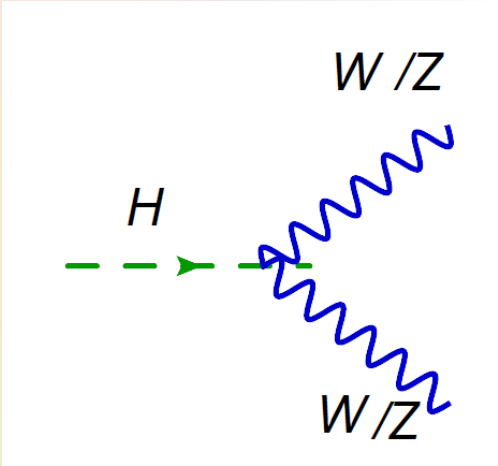


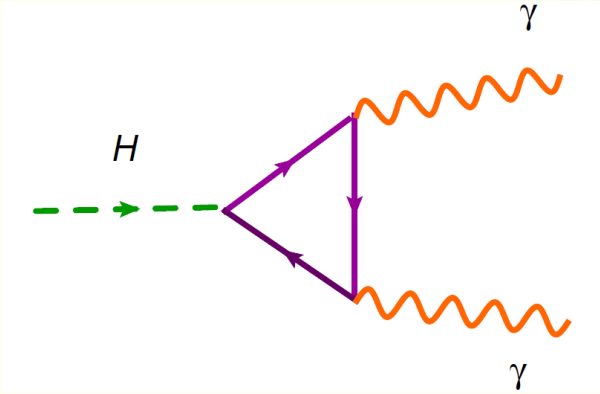
It also predicts one extra particle:The Higgs boson

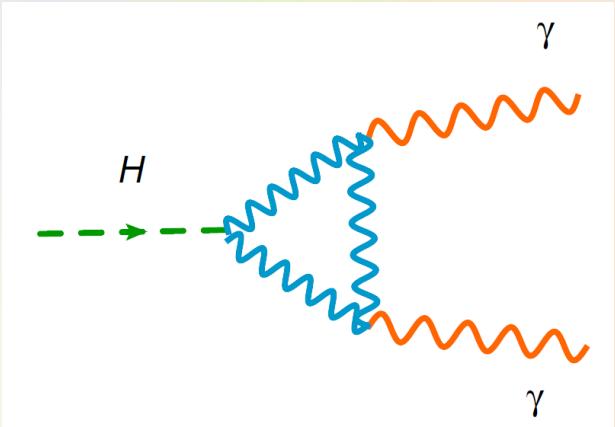
Higgs decay in SM



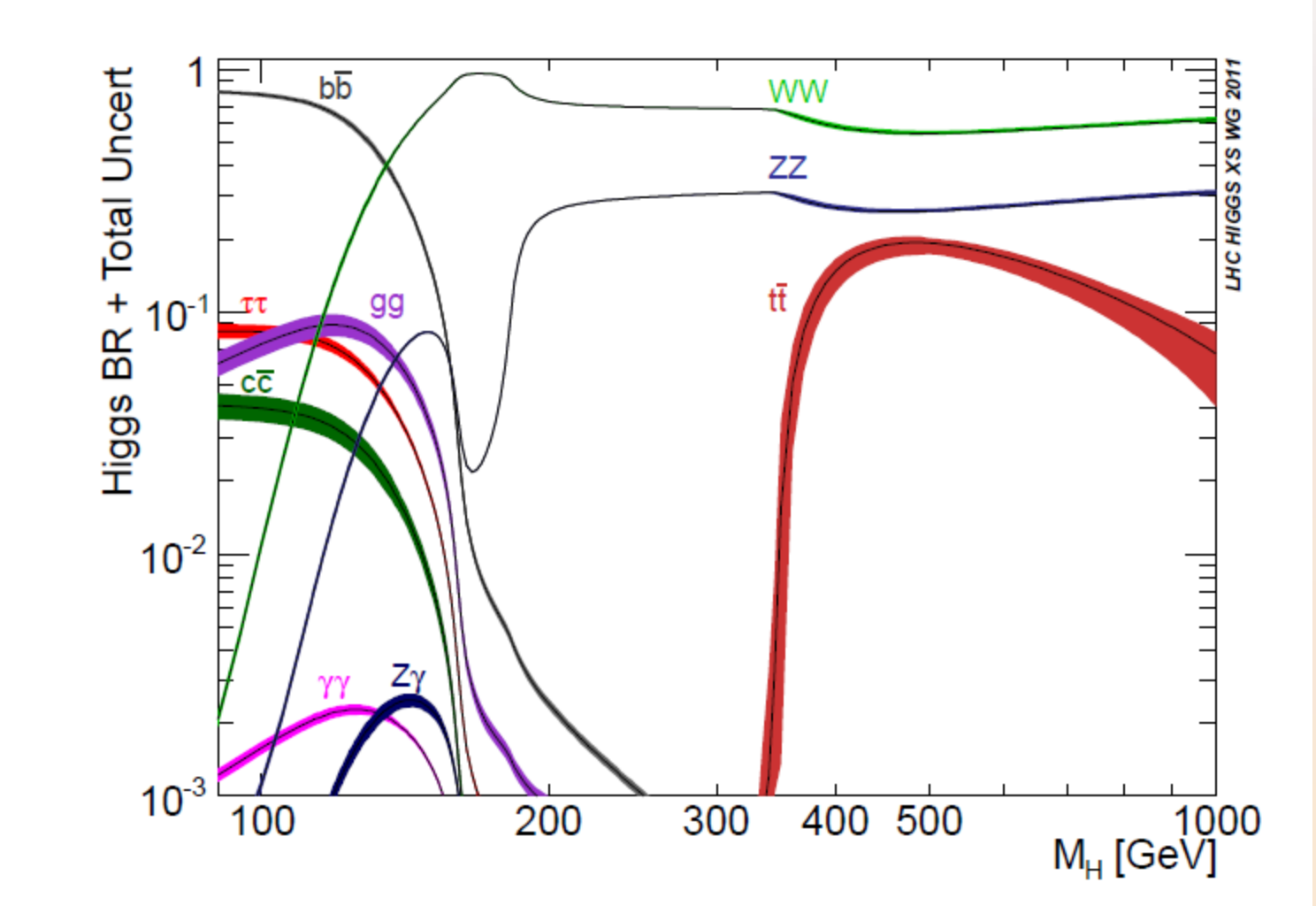








Higgs decay


Higgs BR + Total Uncert
1
10^{-1}
10^{-2}
10^{-3}
100
200
300
400
500
1000
M_H [GeV]
$b\bar{b}$
WW
ZZ
$\tau\tau$
gg
$t\bar{t}$
$c\bar{c}$
$\gamma\gamma$
$Z\gamma$
LHC HIGGS XS WG 2011

NC-Standard Model

Seiberg-Witten Maps

$$S_{NCSM} = S_{fermions} + S_{gauge} + S_{Higgs} + S_{Yukawa}$$

$$f(x) * g(x) = f(x)\exp(\frac{i}{2}\overleftarrow{\partial}_\mu \theta^{\mu\nu} \vec{\partial}_\nu) g(x)$$

$$\int d^4x (f * g)(x) = \int d^4x (f * g)(x) = \int d^4x f(x) g(x)$$

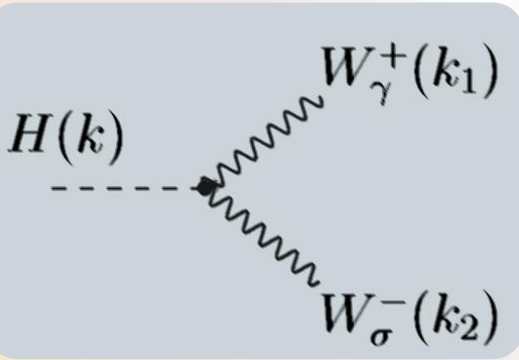
Higgs & Yukawa Sector of NCSM

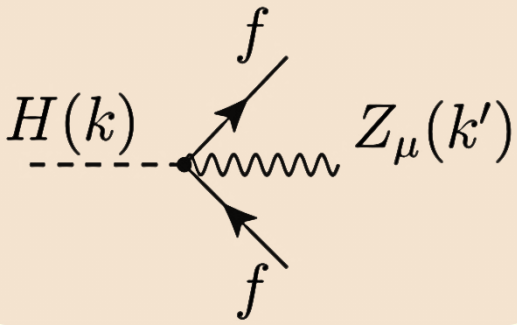
$$S_{\text{Higgs}} = \int d^4x \left((\mathbf{D}_\mu \Phi)^\dagger (\mathbf{D}^\mu \Phi) - \mu^2 \Phi^\dagger \Phi - \lambda (\Phi^\dagger \Phi)^2 \right)$$
$$+ \frac{1}{2}\, \theta^{\alpha\beta} \int d^4x\, \Phi^\dagger \left(\mathbf{U}_{\alpha\beta} + \mathbf{U}^\dagger_{\alpha\beta} + \frac{1}{2}\mu^2\, \mathbf{F}_{\alpha\beta} - 2i\lambda\, \Phi (\mathbf{D}_\alpha \Phi)^\dagger \mathbf{D}_\beta \right) \Phi$$

$$S_{\psi,\ \text{Yukawa}} = \int d^4x \sum_{i,j=1}^{3} \Big[\bar{\psi}^{(i)}_{\text{down}} \left(N^{V(ij)}_{dd} + \gamma_5\, N^{A(ij)}_{dd} \right) \psi^{(j)}_{\text{down}}$$
$$+ \bar{\psi}^{(i)}_{\text{up}} \left(N^{V(ij)}_{uu} + \gamma_5\, N^{A(ij)}_{uu} \right) \psi^{(j)}_{\text{up}}$$
$$+ \bar{\psi}^{(i)}_{\text{up}} \left(C^{V(ij)}_{ud} + \gamma_5\, C^{A(ij)}_{ud} \right) \psi^{(j)}_{\text{down}}$$
$$+ \bar{\psi}^{(i)}_{\text{down}} \left(C^{V(ij)}_{du} + \gamma_5\, C^{A(ij)}_{du} \right) \psi^{(j)}_{\text{up}} \Big] \ .$$

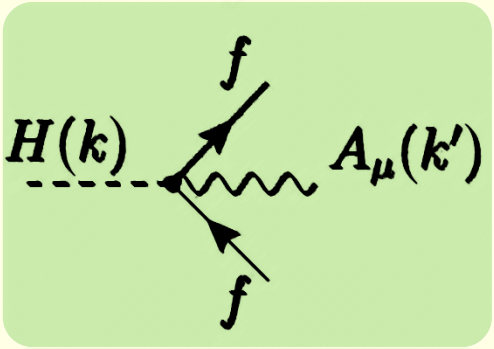
NC Feynman Rules for Higgs

$$\frac{M_W^2}{2v}\{4ig^{\sigma\gamma} + k^\mu(k_1+k_2)_\mu\theta^{\sigma\gamma} + k_\beta(k_2^\gamma\theta^{\sigma\beta} - k_1^\sigma\theta^{\gamma\beta}) + k_\beta(k^\gamma\theta^{\sigma\beta} - k^\sigma\theta^{\gamma\beta}) + k_\beta(k_1-k_2)_\alpha g^{\gamma\sigma}\theta^{\alpha\beta} + m_H^2\theta^{\gamma\sigma}\}$$



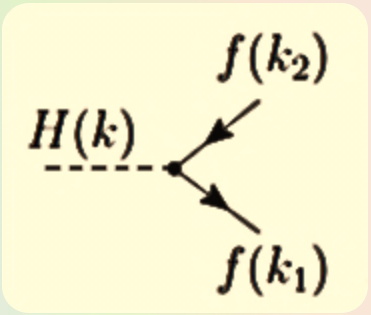


$$\frac{m_f M_Z}{2v^2}\theta^{\mu\nu}[C_{V,f}(2k+k_1-k_2)_\nu - \gamma_5 C_{A,f}(k_1+k_2)_\nu]$$

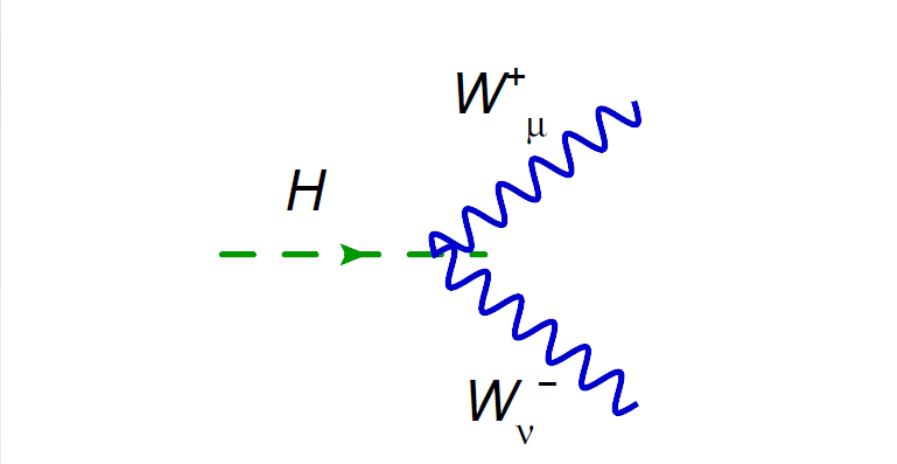


$$\frac{eQ_f}{2v}m_f\theta^{\mu\nu}(k-k')_\nu$$

$$-\frac{m_f}{v}(i+\frac{\theta^{\mu\nu}}{2}k_\mu k_{1\nu})$$



$H \longrightarrow W^+W^-$

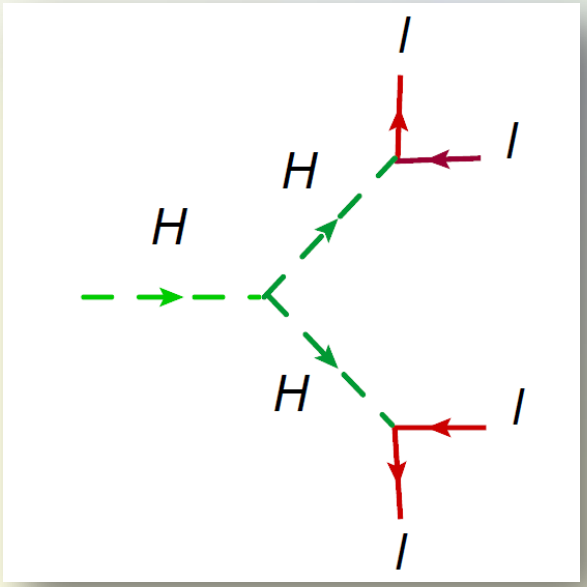


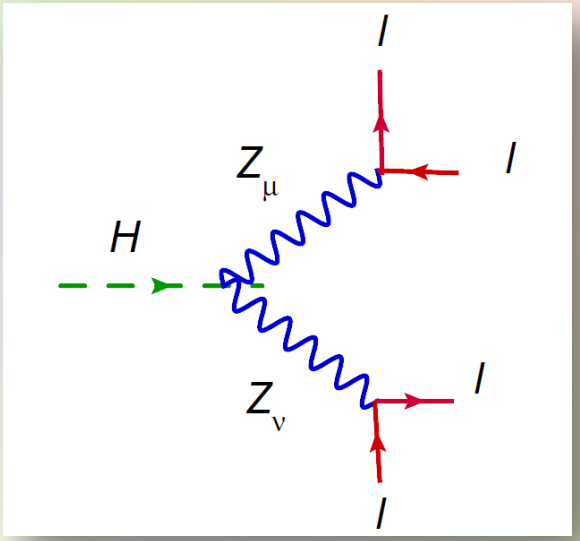
$$|M|^2 = \left(\frac{M_H}{v}\right)^2 \left(\frac{M_H^2}{4} - M_W^2\right)\left[2M_W^4 + \left(\frac{M_H^2}{2} - M_W^2\right)^2\right]\left|\theta^{0i}\right|^2$$

$$\Gamma_{NC} = \frac{\left|\theta^{0i}\right|^2}{8\pi v^2}\left(\frac{M_H^2}{4} - M_W^2\right)^{\frac{3}{2}}\left(3M_W^4 + \frac{M_H^4}{4} - M_H^2 M_W^2\right)$$

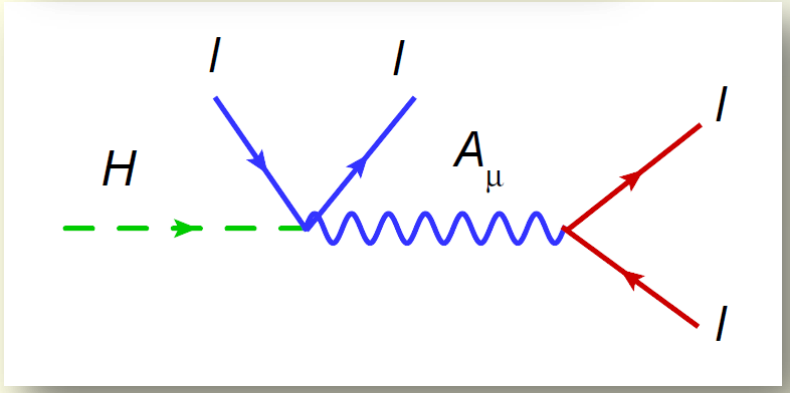
$$\Lambda_{NC} \geq 60GeV$$

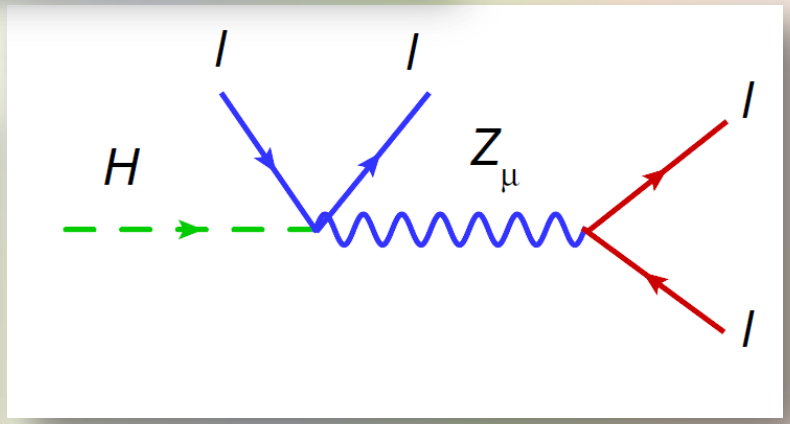
Feynman Diagram for $H \longrightarrow llll$





$\Lambda_{NC} \geq 9GeV$





Conclusion

- There are new feynman Rules for Higgs sector in NCSM
- Higgs decay channels from new vertices are negligible
- Higgs decay to four lepton in NCSM is negligible.
- NC order for Higgs decay to W^+W^- is $\Lambda_{NC} \geq 60 GeV$

Thank you